

**THE COMMONER SPECIES OF ANIMALS AND THEIR DISTRIBUTION
ON AN INTERTIDAL PLATFORM AT PENNINGTON BAY,
KANGAROO ISLAND, SOUTH AUSTRALIA**

By S. J. EDMONDS*

[Read 8 July 1948]

CONTENTS

1	INTRODUCTION AND ACKNOWLEDGMENTS	167
2	GENERAL DESCRIPTION OF THE PLATFORM AND ITS ENVIRONMENT	167
3	EXPLANATION OF TERMS:	168
4	REGIONS OF THE PLATFORM:	168
	A. Supra-littoral	168
	B. Littoral	168
	C. Sub-littoral Fringe	170
5	SUMMARY	175
	APPENDIX A. Numerical Density of some Molluscs	175
	APPENDIX B. List of Species collected	176

1. INTRODUCTION AND ACKNOWLEDGMENTS

This paper deals with the commoner species of animals and their distribution on a rock platform at Pennington Bay on the south coast of Kangaroo Island, South Australia. An examination of the fauna of this reef has been made by the writer during a number of University vacations from 1944-47. At the same time Mr. H. B. S. Womersley of the Botany Department, University of Adelaide, has been working on the algal ecology of the island and this reef (Womersley 1947, 1948).

The author wishes to acknowledge the help which he has received from many people. His thanks are due to Prof. T. H. Johnston and Mrs. P. M. Thomas of the Adelaide University, and Miss E. C. Pope of the Australian Museum, Sydney, for advice and encouragement, and to Mr. H. B. S. Womersley for discussions and suggestions; and to the following who identified many of the specimens collected: Mr. H. M. Hale (Museum, Adelaide)—Crustacea; Mr. B. C. Cotton (Museum, Adelaide)—Molluscs; Dr. E. A. Briggs (University, Sydney)—Hydroids; and Mr. K. Sheard (C.S.I.R.)—Amphipods. He also wishes to thank those senior students and research assistants of the Zoology Department of the Adelaide University, in particular Mr. R. Specht and Miss H. G. Clark, who have helped with the collecting and counting.

2. A GENERAL DESCRIPTION OF THE ROCK PLATFORM AND ITS ENVIRONMENT

Although a complete description of the reef has been given by Womersley (1948) it seems necessary that a brief description, at least, should also be made here in order to give this paper some unity. The platform, which is almost horizontal, lies between the levels of high and low water neap tides and is composed of calcareous sand rock of recent origin. It is washed by the waters of the Southern Ocean and at high tide wave action over most areas of the reef is strong. The substratum is generally rocky. Near the shore, towards the west, sand is usually deposited on the rock. A few large boulders, which can be moved only with great difficulty, rest on the platform at the eastern end of the reef.

* Zoology Department, University of Adelaide.

They have formed where the cliffs have collapsed. No loose stones are to be found, and therefore those communities which usually inhabit the undersurfaces of loose rocks are not present. Most of the animals which live on the reef cling firmly either to the rock or the dense growth of algae which is present. Womersley (1948) has drawn attention to the richness and dominance of the algae on this reef. There are two small rock pools filled by wave splash high up in the supra-littoral region. Further description of the reef is given, where necessary, in other parts of this paper.

About a mile west of the main reef at Pennington there is a much smaller rocky formation where the calcareous sand rock has been cut into three or four wave-cut terraces. A study of the distribution of the animals on this reef has thrown light on the zonation of the animals on the main reef. When this reef is mentioned it is referred to as the "western terraced reef".

An account of the environmental conditions of the coasts of Kangaroo Island and at Pennington Bay is given by Womersley (1947) and (1948). The hydrological determinations were made jointly by us. At Pennington Bay the tidal range is about $2\frac{1}{2}$ feet at spring tides and $1\frac{1}{2}$ feet at neap tides. The temperature of sea measured off the edge of the platform at irregular intervals during the year ranges from 19.0° C. in summer to 13.5° C. in winter. The temperature of the water on the reef is usually within 1° C. of the sea temperature. The salinity of the water determined during summer months varies between $35.2^{0}/_{00}$ and $35.4^{0}/_{00}$, and its pH, by colorimetric methods is about 8.2-8.3.

3. EXPLANATION OF TERMS

The terms "*littoral*", "*supra-littoral*" and "*sub-littoral fringe*" are used in this paper to describe the different horizontal regions on the rock platform. The meaning given to these terms by workers in marine ecology often differs slightly. The author in this paper has adopted the usage of Oliver (1923) and Cranwell and Moore (1938), and given a broad meaning to the term "*littoral*". The littoral or intertidal is considered to be that region lying between the highest wash of the waves and the level of the low spring tides. The supra-littoral is the spray region, and its lowest levels may be washed or splashed during exceptionally rough weather. The sub-littoral fringe is a very narrow region which is usually covered by the sea but which is sometimes exposed at the lowest tides in very calm weather or at low tide when the wind is off shore.

Elizabeth Pope (1943), in her study of the plant and animal communities at Long Reef, New South Wales, fixed the upper limit of the littoral region as that of the average high water spring tides. On account of the much smaller tidal range and the roughness of the sea at Pennington Bay the heights of the tides cannot be determined as precisely as at Long Reef.

Early in the study of the fauna of this and neighbouring reefs, it was seen that in many cases the distribution of animal life is closely connected with the distribution of plant life. This is particularly noticeable in the case of the weed-feeding molluscs. Consequently reference is made in this paper from time to time to the algae found on the reef.

4. REGIONS OF THE PLATFORM

A. SUPRA-LITTORAL

The supra-littoral is rocky and the dominant inhabitant is the periwinkle, *Melarapha unifasciata*. Algae are not well established, but patches of a lichen of the genus *Lichina* are occasionally observed. *M. unifasciata* climbs highest of all the molluscs on the reef and is found in great numbers on the tops and

MAP SHOWING DISTRIBUTION OF ANIMALS
ON A PLATFORM AT PENNINGTON BAY.

Fig. 1.

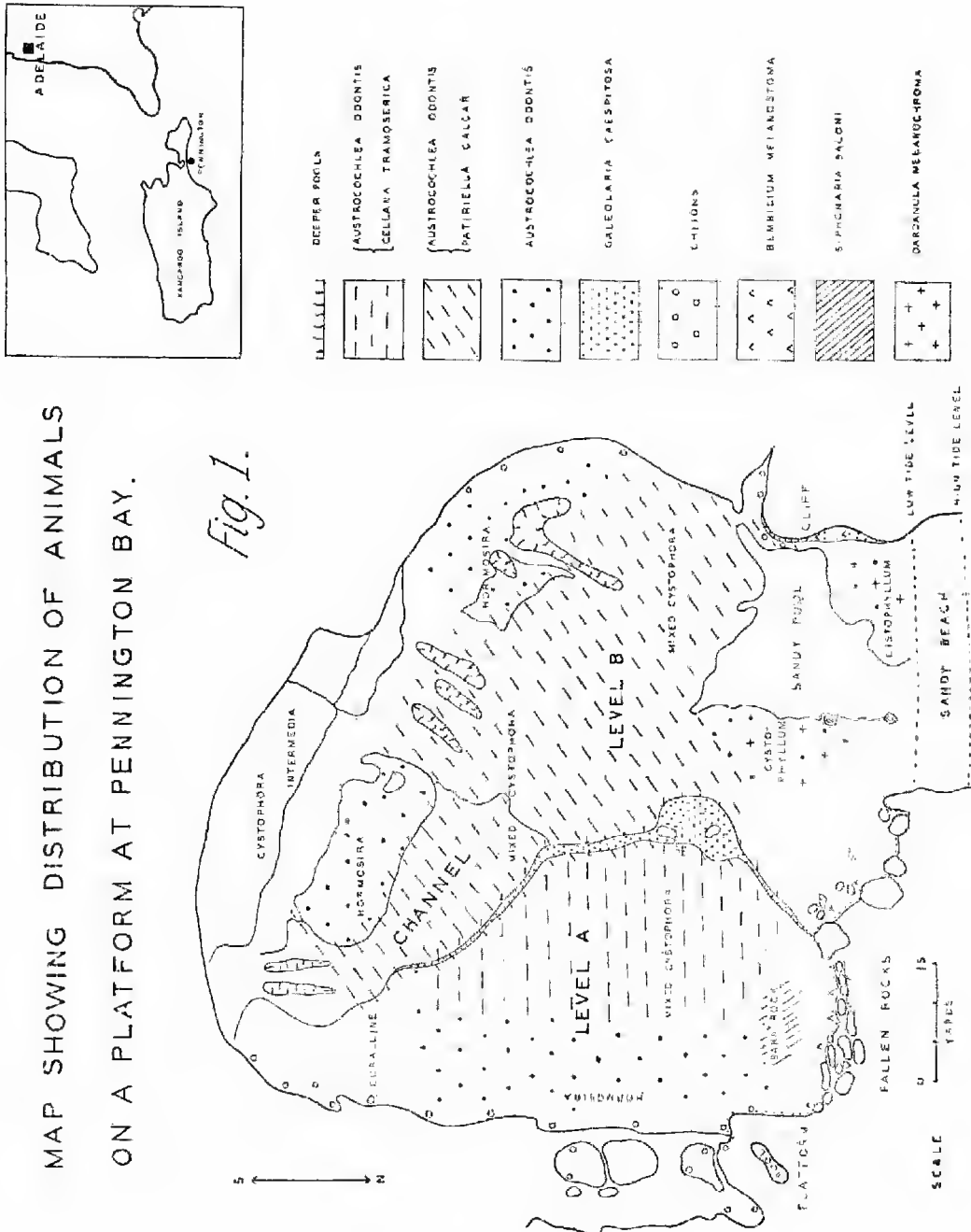


Fig. 1

sides of rocks. A fact perhaps worth recording is that the noddwink, *Noddi-littorina tuberculata*, found on the highest levels at Long Reef, New South Wales, does not occur here.

In the more sheltered parts of the supra-littoral the quick moving isopod, *Ligia australiensis*, is common and hurries out of sight as one walks over the rocks. Occasionally the large yellow crab, *Leptograpsus variegatus*, is found in the lower levels sheltering in crevices or under ledges of rock.

At the eastern end of the reef there are two small shallow and isolated rock pools filled with water from splash and spray. In summer months the temperature of the water in these pools has been as high as 35° C., and the salinity 40.2‰. The following species have been collected from them: *Meluraphc uni-fasciata*, which forms thick clusters at the edge of the water, and occasionally *Bembicium melanostoma*, *Siphonaria baconi*, *Siphonaria diemenensis* and *Galeolaria caespitosa*.

B. LITTORAL

The greatest area of the reef lies in this region. The upper limit of the littoral varies from 1 to 5 feet above the level of high water spring tides, and the lower limit is that of the low water spring tides. The littoral consists of (a) the more or less vertical cliff face at the rear of the reef, some immovable boulders at the eastern end and an area of sand towards the western end of the platform, and (b) the platform itself which lies between the levels of high and low water neap tides. An idea of the size and shape of the platform can be obtained from fig. 1. Although the platform appears to be horizontal, the drainage of the water from its surface shows that it dips slightly towards the west. A most noticeable structure on the platform is a narrow ledge of rock 2 to 5 inches high which arises at the south-east corner, runs to the centre of the reef and then curves to the north-east corner. The highest levels of the platform are the areas between this ledge and the shore (level A in fig. 1) and the outermost parts of the platform, marked by a very dense growth of *Hormosira*. A narrow channel, 6 to 12 inches lower than level A, arises between the ledge and the *Hormosira* at the south-east corner of the platform. This channel runs south-west, gradually widens out and eventually becomes the main level of the platform near a sandy pool at the north-west corner (level B in fig. 1). This sandy pool always contains water. The surface of the platform is rocky and uneven and contains depressions and holes from 1' to 2' 6" deep. A thin layer of loose sand up to 1" thick may be deposited on the rocky surface of both levels A and B near the shore. Although the platform is above the level of the low tides its surface is rarely dry. There are two reasons for this. Firstly, the platform is so eroded and uneven that a considerable quantity of water is always retained on its surface when the tide recedes. Secondly, wave action even at low tide is strong and waves which break against the seaward face of the platform wash over its surface. There always appears to be a wash of water down the channel to the north-west corner. At low tide the dense growth of algae tends to lie flat on the reef, thus reducing the exposure of its surface. The eastern and western faces of the reef are either vertical or undercut by wave action. The seaward face of the reef is very uneven, broken and dissected.

a. ANIMALS ON THE CLIFF FACE AT THE REAR LITTORAL

The fauna of this subdivision of the littoral consists chiefly of barnacles, molluscs and serpulid worms.

BARNACLES

(i) The highest level of the littoral is marked by a well-developed zone of barnacles of which *Chthamalus antennatus* is the most numerous. *C. antennatus* occurs on the tops and sides of rocks below high water spring tide level and on rocks above the high water line which are splashed or washed. Algae rarely occur at this level. Small groups of the honeycomb barnacle, *Chamaesipho columna* are found here and there amongst the *Chthamalus* at the lower levels. Well developed communities of *Chamaesipho columna* have been noticed on sloping rock surfaces at other localities along this coast. Adult and juvenile specimens of *Melaraphe unifasciata* occur amongst the barnacles of this zone. Tubes of the polychaete, *Galeolaria caespitosa*, are scattered where the rocks are well splashed or washed. *C. antennatus* and *G. caespitosa* often cluster together in the small gutters or channels down which water drains back to the sea.

(ii) The barnacle, *Tetrachita purpurascens* forms a covering on the tops and sides of rocks and on the undersurfaces of overhanging cliffs which are subject to wash and wave action and which are protected from the sun. The alga, *Symphoca hydnoides*, occurs in the same situation.

(iii) In the rougher and more exposed parts of the littoral at the eastern and western extremities of the reef where the cliff face is protected from the sea only by a narrow platform or by fallen rocks the surf barnacle, *Catophragnus polymerus*, can be collected. A few isolated specimens of *Balanus nigrescens* also occur here. These two barnacles are not common on this platform, but at many other localities along the coast they form well-developed communities. *Balanus nigrescens* at these places is found in the roughest parts of littoral where the sea surges up over rocks. There is a particularly good development of *Catophragnus polymerus* below the *Chthamalus* on the cliff face of the western terraced reef at Pennington Bay.

MOLLUSCS

The lower level of the barnacle zone gradually merges with a zone of molluscs consisting of (a) a band of gastropods of the *Notoacmea-Siphonaria* type and (b) a narrow and sharply defined band of the blue-black bivalve, *Modiolus pulcx*. Specimens of *Melaraphe unifasciata*, *Chthamalus antennatus* and *Galeolaria caespitosa* are scattered throughout this mollusc zone. *M. unifasciata*, however, rarely extends as low as the *Modiolus*, but it is common to find specimens of *C. antennatus* growing on the bivalve.

(i) The *Notoacmea-Siphonaria* band of molluscs contains the following species: *Notoacmea scabrilirata*, *Notoacmea septiformis*, *Actinoleuca calamus*, *Chiazacmea conoidea*, *Siphonaria diemenensis*, and sometimes *Bembicium melanosoma* and *Siphonaria baconi*. The vertical width of the band varies from 1½' to 5'. The author has not been able to determine satisfactorily the zonation of these gastropods at Pennington Bay. *S. diemenensis*, *S. baconi* and *B. melanosoma* are usually found at the lower levels. *B. melanosoma* occurs only on the more protected rock surfaces where wave action is not strong.

(ii) The band of *Modiolus pulcx* is not as well developed here as it is on the western terraced reef, where it covers a horizontal level about 2' to 3' wide just above the *Hormosira-Actinia* pools. Specimens of the smaller bivalve, *Kellia australis*, are always associated with *M. pulcx*. The latter has not been observed in the more exposed parts of the coast.

SERPULID WORMS

There is a well-developed zone, in which *Galeolaria caespitosa* is most noticeable, on the lower levels of the cliff face where the surface is rounding off to

form the platform. The tubes, however, are not as thick as the dense deposits observed in more sheltered localities on the island, e.g., at Rocky Point near American River, and at Middle River on the north coast. *G. caespitosa* is scattered over a wide area at Pennington in the mid to higher littoral region wherever there is a good movement of water and no sand. It is commonly associated on this reef with the alga *Rizularia firma*. Scattered tubes of *G. caespitosa* and dark blobs of *R. firma* are particularly well developed on the ledge of rock which runs along the shoreward edge of the channel area of the platform. This ledge is about 2"-5" higher than level A and water moves quickly over its surface. Tubes of *G. caespitosa* in much reduced numbers can be found almost anywhere on the platform itself.

OTHER ANIMALS

(i) Where the cliff face is nearer the open sea, and especially where there is a surging of water, a few specimens of the chitons, *Poneroplax costata* and *P. albida*, can be collected. The larger crabs are not common on this reef, probably because it offers them little shelter and protection. The following species have been collected: *Leptograpsus variegatus*, *Cyclograpsus audouinii*, *Ozius truncatus* and *Plagusia chabrus*. At the water level and on moist rock surfaces the amphipod, *Hyale rupicola*, is common.

(ii) The region of the boulders covers only a small portion of the reef towards the eastern extremity of the shore. The boulders, which are large and difficult to move, rest on the rock platform and have been deposited where the overhanging cliffs have collapsed. *Bombicium melanostoma*, *Galeolaria caespitosa* and the alga, *Rizularia firma*, are well established on and near the boulders. A few specimens of the littorinid, *Melanerita melanotragus*, are usually collected here. Both *B. melanostoma* and *M. melanotragus* are far more numerous on the upper levels of the intertidal region of the north and east coasts of the island or in the high rock pools at Vivonne Bay on the south coast. In these places there are more boulders and conditions are calmer. A smaller variety of *B. melanostoma* is very common on the higher levels of the intertidal flats at American River. The boulders afford shelter for the crabs listed above and for a few specimens of the red viviparous anemone, *Actinia leucobrosa*. This anemone is particularly numerous in and around the edges of the *Hormosira* pools of the western terraced reef.

(iii) The sandy portion of the rear part of the littoral consists of loose sand which is inimical to animal life. The small isopod, *Actaecia pallida*, is sometimes collected from the drier sand and the springtail, *Pseudanurida billitonensis*, from the moist sand.

b. ANIMALS ON THE ROCK PLATFORM

Plate XVI, fig. 2 and 3, and plate XVII, fig. 1, give some idea of the richness and density of the algal growth on the rock platform. Womersley (1948) considers the most important of these algal associations to be: (1) a *Cystophyllum muricatum* association which is developed between the sandy pool and the ledge of the main reef; (2) a *Cystophora* complex which covers the greater part of the reef and which contains several species of the genus *Cystophora*, viz., *C. urifera*, *C. subfarcinata*, *C. siliquosa*, together with *Sargassum muriculatum*; (3) a *Hormosira banksii* association which is most prominent on the higher parts at the outermost edge of the platform; and (4) a *Cystophora*-Coralline association on the rougher and more exposed south-east corner.

Weed-feeding molluscs are found in all these algal associations except the *Cystophora*-Coralline association. *Dardanula melanochroma* is found on the *Cystophyllum* and *Austrocochlea odonlis*, and to a less extent *Phasianotrachus*

bellulus and *Zemitrella yorkensis* on the *Cystophora* and *Hormosira*. Particular reference might be made to the widely distributed alga, *C. uvifera*, which is squat and bushy. It is usual to find the following in or on this alga: *Austrocochlea odontis*, *Cominella* spp., *Subinella undulatus*, *Phasianotrochus bellulus*, *Zemitrella yorkensis*, *Gibbula preissiana*, a small white ophiuroid, *Amphipholis squamata*, *Nereis* sp., and numerous amphipods. The dominance of the algae on the outermost part of the reef is most apparent. The rocky substratum around the edge and down the vertical sides of the reef is covered with a thick carpet of short algae. Few animals, except chitons, are found here.

The chief fauna on the higher levels of the platform (level A, in fig. 1) consists of the weed-feeding molluscs, *Austrocochlea odontis* and *Cellana tramoserica*, in the channel region and level B *A. odontis* and the starfish, *Patiriella calcar*, and on the exposed edges of the reef the chitons, *Poneroplax albida* and *P. castata*.

GASTROPODS.

(i) *Austrocochlea odontis*

A. odontis is the most numerous and widely distributed mollusc on the platform and is found in most areas, even in some of the deeper pools and potholes along the outer edge of the reef. It is a strong and active creature and is found on both weed and rock. It seems to have a particular liking for *Cystophora uvifera* and *Hormosira banksii* and is associated with them on many reefs along the coast. With *Cellana tramoserica* it forms the principal animal community on level A, and with the starfish, *Patiriella calcar*, the principal community in the channel and on level B of the platform.

(ii) *Cellana tramoserica*

C. tramoserica lives only on the rocky substratum and apparently feeds on the microscopic algae which grow on its surface. *Austrocochlea odontis* and *C. tramoserica* are the principal fauna on level A. Very few specimens of this mollusc are found in the channel area, and it is never found where sand is deposited. It shows a tendency to gather in the larger depressions on the rocky surface of level A, where it will be exposed only occasionally. At other localities it has been noticed at much higher levels in the littoral, where it must withstand considerable exposure. Such places are the high rock pools at Vivonne Bay and the higher rocks at Cape de Coudie.

(iii) Other gastropods

Specimens of *Siphonaria baconi*, many possessing slightly eroded shells, are scattered over most areas of the platform. The species, however, is very prominent on the higher parts of level A, near the fallen rock area where the rocky substratum bears little algae. *S. baconi* often is found under thin layers of sand. *Patelloida allicostata* is common on the platform, more particularly at the higher levels, e.g., on the ledge which runs across the platform. *Austrocochlea torri* occurs on the higher levels of the platform. *Cominella eburnea* and *Cominella lineolata* are found on the weed, on the rock or in the sand in most parts of the littoral region. Juvenile specimens of *Neothais textilis* and *Subinella undulatus* feed on the reef. They are, however, more numerous near the edges of the platform. *Filoraconus avemone*, *Phasianella ventricosa* and the key-hole limpet, *Sophsinuolepus nigrata*, are sometimes collected on and amongst the algae. *Tethys norfolkensis* appears during the summer months. The algae and the rich epiphytic plant life which grows on it afford shelter, and probably food, for a number of gastropods other than *A. odontis*. Some of these molluscs are *Phasianotrochus bellulus*, *Phasianotrochus eximius*, *Gibbula preissiana*, *Cantharidus pulcherrimus*, *Zemitrella yorkensis* and *Zemitrella semiconvexa*.

STARFISH

The chief fauna of the channel region and level B consists of *Austrocochlea odontis* and the eight-rayed starfish, *Patiriella calcar*. There is little doubt that the starfish are confined to this level because it is never completely exposed. When the tide is very low and the movement of water down the channel very slow and feeble, *P. calcar* seeks shelter in the deeper depressions or under algae. The thin and temporary layers of sand which are sometimes deposited near the sandy pool do not appear to be detrimental to this creature. It is common to find the starfish ingesting fragments of *Corallina cuvieri*. *P. calcar* has been noticed in crevices and pools on this and other reefs well below the level of the low water spring tides. Occasionally small flat isopods are found moving over the arms of the starfish.

CHITONS

The outer edges of the reef are subject to strong wave action and are covered with algae. *Austrocochlea odontis* is rare here and is found only where there is shelter, e.g., in cracks and under small ledges. The chitons, *Poneroplax albida* and *P. costata* are the only animals established on this part of the reef. They are found in shallow depressions on the edges and on the vertical sides of the platform and extend down to the sub-littoral fringe. Their plates are usually covered with tufts of small algae.

OTHER ANIMALS

Crustacea are abundant in the algae. The small crabs, *Ilicarcinus ovatus*, the weed crab, *Naxia tumida*, and the sea centipedes, *Paridotea munda* and *Euidotea peronii* are usually found in the weed. *Ozius truncatus* and *Eriochelip spinosus* are rare. A sphaeromid isopod is often collected in the algae but no burrows have been observed in the rock. The following amphipods have been identified, *Waldeckia chevrouxi*, *Blasmodius subcarinata*, *Amphithoe australiensis*, *Hyale nigra*, *Hyale rupicola*, and *Calliopius* sp.

The reddish-brown *Holothuria fuscocincta* is often found in the algae on the sand which collects around the holdfasts of the more bushy species of weed. A small white and active ophiuroid, *Amphipholis squamata*, is usually collected at the base of *C. uvifera*.

The anemones, *Anthopleura muscosa* and *Briodactis veratra*, occur on the platform. *A. muscosa*, with shell fragments attached to its exterior, is found in cracks, crevices and under ledges, while *B. veratra* is commoner amongst the algae.

Polychaets of the genus, *Nereis*, shelter in the holdfasts of the algae and tubes of *Spirorbis* sp. are common, especially on *Sargassum*. Scattered tubes of *Galeolaria cespitosa* occur on the rocky substratum where there is a good flow of water.

Two small fish are sometimes collected from amongst the weed; they are *Clinus perspicillatus* and *Syngnathus cirilrostris*. Smaller specimens of *Myrus elongatus* and *Mugil cephalus* have been caught in and near the sandy pool. Tardigrades and numerous free living nematodes, including *Epsilonema* sp. and *Trichoderma* sp., have been identified in material scraped off two rocks which project from the sand near the shore. Ascidians and sponges do not occur on the platform itself. Pycnogonida and nemertines are occasionally collected from among the algae.

C. SUB-LITTORAL FRINGE

The sub-littoral fringe comprises those parts of the reef near the level of the low spring tides which are exposed either momentarily between waves or when an offshore wind coincides with a low spring tide. It is the most inaccessible region of the platform and one rarely has an opportunity of examining its fauna.

The densest algal growth on the reef is found here and the rock is covered with plant life. Womersley (1948) points out that in an area of 4 or 5 square yards it is common to find 40 or 50 different species of algae and that epiphytic growth is profuse. The dominant algal association is one of *Cystophora intermedia*; other larger algae are *Sargassum bractiolosum* and *Ecklonia radiata*. The smaller algae are listed in Womersley's paper. The dominance of the plant life in the sub-littoral fringe and, as far as can be determined, the sub-littoral on this and other reefs of the south coast of this island is almost complete. The commonest animal in the sub-littoral fringe is the stalked ascidian, *Boltena australis* (*Pyura australis*), but its numbers, however, are not great. *B. australis* is found on those surfaces of the sub-littoral fringe which are almost vertical and it is usually concealed amongst the larger algae. Sometimes the chitons, *Poneroplax costata* and *P. albida*, extend down from the littoral into this region.

The *Balanus nigrescens*-*Pyura praeputialis* community of the sub-littoral fringe at Long Reef, New South Wales (Pope 1943), is not present at Pennington and has not yet been observed in South Australia by the writer. Nor is there here any animal growth which corresponds to the dense *Pyura stolonifera* community of the sub-littoral region at False Bay, South Africa (Stephenson 1937).

Larger specimens of *Subnivalia undulatus*, *Subnivalia torquatus*, *Neothais textiliosa* and *Haliotis rosi* can be seen attached to rocks. Most of the other gastropods which live on the rock platform are not found in the sub-littoral fringe. Specimens of *Patiriella calcar* find their way into cracks and crevices. Colonial hydroids grow on many of the larger algae. The commonest species are *Sertularia minuta* and *Orthopyxis macrogona*, the latter usually being found on *Sargassum bractiolosum*. A sandy-coloured sponge is sometimes collected in the holdfasts of some of the algae. A red sponge and a red encrusting polyzoan are common on the ledges of rocks in this zone. When conditions are very calm a purple compound ascidian, *Austrobatryllus* sp., is sometimes collected from beneath the algae on the broken outer edges of the reef.

The fishes, *Scorpius georgianus*, *Pseudolabrus psittaculus*, *Pseudolabrus punctulatus* and *Myxus elongatus* have been caught off the eastern edge of the platform.

5. SUMMARY

The fauna of an intertidal platform of calcareous sand-rock has been examined. Wave action is strong and no loose stones are present. The most prominent animals on the cliff face at the rear of the reef are littorinid molluscs (*Melaraphis unifasciata*), barnacles (*Chthamalus antennatus*), molluscs and serpulid worms (*Galeolaria caespitosa*). On the platform itself the most prominent and the dominant life form is a thick growth of algae (*Cystophyllum muricatum*, *Cystophora* spp., *Sargassum muriculatum*, *Hormosira banksii*, Corallines and epiphytic algae). Weed-feeding molluscs (*Austrocochlea odontis* and *Cellana tramoserica*) are abundant on the algae and the platform respectively. Starfish (*Patiriella calcar*) appear on the lower levels and chitons (*Poneroplax albida* and *P. costata*) on the exposed edges of the reef. Algae (*Cystophora intermedia*, *Sargassum bractiolosum*, *Ecklonia radiata*, numerous smaller species and profuse epiphytic growth) are almost completely dominant in the sub-littoral fringe. Ascidians (*Boltenia* (syn. *Pyura*) *australis*) are found, but not in great numbers, in the sub-littoral fringe. A list of the species collected is also given.

APPENDIX A

In order to determine the density of the mollusc and starfish population a metal frame 0.5 metre x 0.5 metre was constructed and thrown at random on the rocky substratum of the reef. The numbers of molluscs on both weed and

rock and starfish falling in the area enclosed by the frame were then counted. As a result of 100 throws on each of level A and level B the following averages were obtained:

	Level A	Level B
<i>Cellana tramoserica</i> - - -	2.8	0.4
<i>Austrocochlea odontis</i> - - -	10.5	12.0
<i>Patelloida alticostata</i> - - -	0.5	0.2
<i>Cominella</i> spp. - - -	1.2	2.1
<i>Zemitrella</i> spp. - - -	0.5	0.7
<i>Siphonaria baconi</i> - - -	5.0	0.4
<i>Phasianotrochus bellulus</i> - - -	0.2	0.4
<i>Subnivalia undulatus</i> - - -	0.1	0.9
<i>Neothais textiliosa</i> - - -	—	0.2
<i>Patiriella calcar</i> - - -	0.1	4.0

APPENDIX B

List of animals collected at Pennington Bay

The species named are littoral except where otherwise indicated: sl. = supra-littoral; sbl. = sub-littoral; l. = littoral; † denotes that the animal is common.

COELENTERATA—*Actinia tenebrosa* Harqu., *Anthopleura muscosa* Drayton, *Bunodactis veratra* Drayton, † *Sertularia minuta* Bale sbl., † *Orthopyxis macrogonia* (Lenden.) sbl.

PORIFERA—grey sponge growing on weed, red sponge. sbl.

NEMATODA—*Trichoderma* sp., *Epsilonema* sp.

NEMERTINEA—yellow nemertine, white nemertine.

POLYCHAETA—*Nereis* sp., † *Spirorbis* sp., † *Galcolaria caespitosa* Lamarck.

CRUSTACEA—† *Chthamalus antennatus* Darwin, *Catophragnus polymerus* Darwin, *Balanus nigrescens* Lamarck, † *Tetraclita purpurascens* (Wood), *Chamaesipho columna* Spengler, † *Ligia australiensis* (Dana) sl., *Paridotea munda* (Hale), *Euidotea peronii* (M. Edwards), *Actaecia pallida* (Nich and Barn.), *Exoedicerus muculosus* Sheard, † *Waldeckia chevreuxi* (Stebb.), *Elasmopus subcarinatus* (Haswell), *Amphithoe australiensis* Bate, *Hyale nigra* (Haswell) † *Hyale rupicola* (Haswell), *Calliopus* sp., *Ozius truncatus* (Edwards), *Leptograpsus variegatus* (Fabr.) sl. and l., *Plagusia Chabrus* (Limaeus), *Cyclograpsus audouinii* (M. Edwards), † *Halicarcinus ovatus* (Stimpson), *Eriocheir spinosus* (M. Edwards), *Naxia tumida* (Dana).

MOLLUSCA—† *Poneroplax albida* (Blainville) l. and sbl., † *Poneroplax costata* (Blainville) l. and sbl., *Haliotis roei* Gray, *Sophismelepas nigra* Sowerby, † *Cellana tramoserica* Sowerby, † *Patelloida alticostata* Angas, *Actinoleuca calamus* Crosse, † *Chiosacmea conoidea* Qu. and Gaim., † *Notoacmea septiformis* Angas, † *Notoacmea scabrilirata* Angas, *Cantharidus pulcherrimus* Wood, † *Phasianotrochus bellulus* Dunker, † *Austrocochlea odontis* Wood, *Austrocochlea torri* Gray, † *Gibbula preissiana* Philippi, † *Subnivalia undulatus* Solander l. and sbl., *Subnivalia torquatus* Gmelin l. and sbl., *Phasianella ventricosa* Swainson, *Melanerita melanotragus* Smith, † *Melagrapha unifasciata* Gray sbl., † *Bembicium melanostoma* Philippi, † *Dardanula melanochroma* Tate, *Sabia comica* Schumacher (on other shells), † *Neothais textiliosa* Lamarck l. and sbl., † *Zemitrella yorkensis* Crosse, *Zemitrella semiconvexa* Crosse, † *Cominella eburnea* Reeve, † *Cominella lineolata* Lamarck, *Floraconus anemone* Lamarck, *Tethys norfolkensis* Sowerby, † *Siphonaria diemenensis* Sowerby, † *Siphonaria baconi* Reeve, † *Modiolus pulex* Lamarck, † *Kellia australis* Lamarck, *Hapalochlaena maculosa* Hoyle.

- INSECTA—*Pseudanurida billitonensis* (Schött).
 POLYZOA—red eucrusting type sbl.
 ECHINODERMATA—+ *Patiriella calcar* Lamarck, *Amphipholis squamata* Delle Chiaje, *Holothuria fuscocinerea* Jäger.
 ASCIDIANS—*Boltenia australis* (*Pyura australis*) Herdman sbl., *Austrobotryllus* sp., sbl.
 PISCES—*Myxus elongatus* sbl., *Scorpius georgianus* sbl., *Pseudolabrus psittaculus* sbl., *Pseudolabrus punctulatus* sbl., *Clinus perspicillatus*, *Syngnathus curtirostris*.

REFERENCES

- BRIGHT, K. M. F. 1938 South African Intertidal Zone and its Relation to Ocean Currents, II and III. Trans. Roy. Soc. of Sth. Africa, 26, 49-65, 67-88
 CHAPMAN, V. J. 1946 Marine Algal Ecology. Bot. Rev., 12, 628-672
 COLMAN, J. 1933 Nature of Intertidal Zonation of Plants and Animals. J. Mar. Biol. Assoc. U.K., 18, 435-476
 COLMAN, J. 1940 Fauna Inhabiting Intertidal Seaweeds. J. Mar. Biol. Assoc. U.K., 24, 129-183
 COTTON, B. C., and GODFREY, F. K. 1938 and 1940 Molluscs of South Australia. Pts. I and II. Government Printer, South Australia
 CRANWELL, L. M., and MOORE, L. B. 1938 Intertidal Communities of Poor Knight's Island, N.Z. Trans. Roy. Soc. N.Z., 67, 375-407
 EVANS, R. G. 1947 Intertidal Ecology of Selected Localities in Plymouth Neighbourhood. J. Mar. Biol. Assoc. U.K., 27, No. 1, 173-217
 HALE, H. M. 1927 Crustacea of South Australia, Parts I, II and III. Government Printer, S. Aust.
 HEDLEY, C. 1915 Ecological Survey of Sydney Beaches. J. Roy. Soc. N.S.W., 49, 1-77
 JOHINSTON, T. H. 1917 Ecological Notes on the Littoral Fauna and Flora of Caloundra, Queensland. Qld. Nat., 2, 53-63
 JOHINSTON, T. H., and MAWSON, P. M. 1946 A Zoological Survey of Adelaide Beaches. Handbook of 25th Meeting of Aust. and N.Z. Assoc. of Advanc. of Science, 42-47
 MICHAELSEN, W., and HARTMEYER, R. 1905 Die Fauna Südwest-Australiens. Ergebnisse der Hamburger Südwest-australischen Forschungsreise.
 OLIVER, W. R. B. 1923 Marine Littoral Plant and Animal Communities in New Zealand. Trans. N.Z. Institute, 54, 496-545
 PEARSE, A. S. 1939 Animal Ecology. McGraw Hill, N.Y. and London
 POPE, E. C. 1943 Animal and Plant Communities on the Coastal Rock Platform at Long Reef, N.S.W. Proc. Linn Soc. N.S.W., 68, 222-254
 POPE, E. C. 1945 Simplified Key to Sessile Barnacles. Records of Aust. Museum, 21, No. 6, 351-372
 STEPHENSON, T. A., STEPHENSON, A., and DU TOIT, C. A. 1937 The South African Intertidal Zone and its Relation to Ocean Currents (Indian Ocean). Trans. Roy. Soc. of South Africa, 24, 345-382
 WAITE, E. R. 1923 The Fishes of South Australia, Govt. Printer, S. Aust.
 WOMERSLEY, H. B. S. 1947 Marine Algae of Kangaroo Island, I. Trans. Roy. Soc. S. Aust., 71, 228-252
 WOMERSLEY, H. B. S. 1948 Marine Algae of Kangaroo Island, II. Trans. Roy. Soc. S. Aust., 72, 143-166